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XXI.—*A Comparative View of the more important Stages of Development of some of the higher* Cryptogamia *and the* Phanerogamia. By Charles Jenner *.

For some time past, the few hours of leisure I have been able to spare from the pressing engagements of business, have been employed in investigating the germination and reproduction of the higher Cryptogamic plants; those Cryptogamic plants in which sexual organs have been recognized, and the reproductive spores of which, at one or other stage of their development, are enclosed in a testa or case. My attention was early directed to the following facts :—

First. That in different orders of these plants, the spores are enclosed in their testæ, and set free from their connexion with the parent plant, at altogether different stages of development. For example,—

The vesicular spore of a Moss is fecundated before it obtains an enveloping case and is set free; whereas the spore of a Fern, when it is detached, consists only of a vegetative axile cell, which developes into a thallus upon which is borne the fecundating organ as well as the archegonial cell. And

Secondly. That very varying stages of development are arrived at, within the enclosure of the spore-case, in the several orders of the higher Cryptogams: thus—

In Ferns, the spore developes only externally to the spore-

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case the cellular frond which bears the archegonial cells, whereas in the *Selaginella* the analogous cellular expansion is developed within the spore-case.

It thus became apparent to me at the very outset of my investigations, that in considering the question of the entire cycle of an individual life among these plants, we should never lose sight of the fact, that there is no such identity among the spores of the higher Cryptogams, as is supposed to exist among the embryogenic seeds of Phanerogams; and also, that we should err as much in assuming the spore, at the period of its vegetative development, to represent the earliest stage in this cycle, as we should, were we to consider the seed as the first stage of the existence of a Phanerogamous plant, overlooking the origin and development of the embryo, its envelopes and its albumen, and the special relation which these latter bear to the parent plant.

All plants above the lowest possess special cellular structures, within which, as within the ovular envelopes, or in the substance of which, as in the pro-embryo of a Fern, there is produced an embryonal chamber or sac. In the interior of this cell the protoplasm or formative matter is concentrated, from which is evolved the whole after-structure. Thus, in Mosses, in Lycopodals, and in Ferns, as well as in Phanerogamous plants, it is a single cell within which the subsequent development is called forth through the influence of fecundation. This germ-cell is in every case the commencement of the new individual cycle of life.

To enable me to trace, as carefully as I propose, the analogy between the principal organs and stages of development of the higher Cryptogamic plants and the Phanerogamic, I must ask you to dissociate in your minds this germinal vesicle from the structure within which it has its origin. These investing organs are very varied in their form and texture. The most striking differences prevail between them in Gymnospermous plants and Angiospermous plants, and also between them in the orders and even genera of Angiosperms and the several orders of Cryptogams; while, on the other hand, there is an approach to homogeneity in the form, structure, and early general development of the germ-vesicle itself, so that unless we dissever, as it were, this germ-vesicle from those heterogeneous environments (which have only for their purpose the sustentation and preservation of the germ-vesicle), we shall trammel our subject with unnecessary difficulty and fail to attain that clear point of view that is so desirable.

There are thus then certain structures, so intimately asso-

ciated with the germ-vesicle of all but the lowest plants, though totally independent of it, that we can scarcely investigate the course of the one without to some extent entering upon the consideration of the nature and relation of the other. These structures may be called accessory or investing organs, and as examples of them I may mention, the various coats of the ovule, the pro-embryonic frond of Ferns, and the cellular layer which environs the embryonal germ of a Moss, and which afterwards constitutes the spore-case. I may repeat that these investing organs belong to the organic structure of the parent plant; and they do so belong to it, whether they are maintained in their connexion with it, as are the primine and secundine of the ovule, or whether they are disconnected from it, as is the prothallus of a Fern. The first growth therefore to be recognized as independent development, is the vesicular coat which is formed around the concentration of protoplasmic or germinative matter within the embryo-sac. The contents of this vesicle are the immediate resultant of the parent life, the first formative act of the new existence being the cell-wall enclosing these contents. In the unimpregnated stage of the germinal vesicle, its derived power has become isolated, for its processes of assimilation and the varying disposition of the protoplasm must be considered acts of its separate vitality.

I have further to notice generally, that in all plants the separation of the young plant from the old,—of the newly-derived existence from the parent life, is accompanied by a condition of rest, or rather of the capability of resting; for instance, the Phanerogamous embryo within its testa, the vesicle of a Cryptogam within its spore-case.

This resting stage is always carefully arranged for by the provision of suitable integuments and store of endospermous matter. We have seen that the resting stage is attained at varying epochs of development in different orders of plants, and that a more or less amount of development is attained within the particular receptacle of the parent plant. Special organs are modified to suit the special circumstances of each case. Thus, in Angiospermous Phanerogams, for sustentative and nutritive purposes, the coats of the ovule are maintained in their connexion with the axis by means of a funicular cord; whereas the homologous organ of Filices—a free development subsequent to the resting stage—is cellular fibrillæ or rootlets. These fibrillæ of the prothallus of the Fern are, however, not only homologous with the funiculus of the ovule of Angiospermous Phanerogams, but their function is the same, namely that of affording support and nutriment. The funiculus of the ovule then, and the fibrillæ

of the prothallus of the Fern, are, to speak briefly, homologous and analogous organs.

I now proceed to my particular purpose, which is to trace in a general manner the cycle of development of a Moss, a Fern, a Phanerogamous plant, and to trace in outline a few analogies between their more important organs, which, if diverse in appearance and without any very apparent relation, have at least common purposes. Nature is so infinitely varied in her forms of manifestation, and she is so rich in her adaptation of means, yet withal has such a clear and palpable unity of purpose, that on the one hand we need not be surprised at apparent discrepancies, and on the other we need never doubt one common identity.

In the Table (p. 246) I have separated the investing organs from the germinal body, and have shown the relation which I hold the various organs of the plants under review have to each other, and also distinguished the stage of development in each order at which the resting condition is attained; this condition being in every case precursory of detachment from the parent plant. The investing organs may be divided into general and special; the general investing organ being the ovarium in Angiospermous Phanerogams, the theca in Filices, and the archegonium (in its ripened condition the sporangium) in Musci. The special investing organs are those which immediately environ the germinal vesicle; these are, in the Phanerogamia the coats of the ovule, in Filices the pro-embryo, and in Musci the sporular integument which enfolds the nucleal germ, and which finally constitutes the testa of the Moss-spore. The unimpregnated germinal vesicle of the Phanerogamia finds its homologue in the archegonial cell of the pro-embryo of the Fern, and in the embryonal cell within the archegonium of a Moss. The maturation of this cell is only preparative to the fecundative act, or the fertilizing process, whatever that may be, which takes place, in one or other manner not yet determined, in all plants at this stage of progress. The impregnating influence or matter being imparted to this vesicle, embryonal development ensues, and always in the same general manner, varied only by the special varying circumstances of each particular case. The fertilized cell stands on the verge of the active development of an independent vitality. In Ferns the resting stage is passed before impregnation has taken place. The course of growth after impregnation is continuous. The germinal body, by a succession of transverse divisions, obtains the condition of a septate cellular process, longitudinal and radial divisions follow, and a structure is formed which developes an ascending and descending axis, in

due course to disengage from the former a bud, the commencement of a new cycle of individual life.

In Phanerogamia, immediately after fertilization, which I need not say takes place within the ovarium, a transverse septum is formed across and within the germinal vesicle; by successive transverse divisions of the superior half of this germ-cell, a confervoid filament is formed, which has received the name of the suspensor. The suspensor varies in length in different families, orders and genera, being longer in some and shorter in others, but in all it is distinctly a septate cellular process. The inferior moiety of the germ-cell, by a series of longitudinal, transverse, and radial divisions, developes into a radicular portion and a cotyledonary expansion, and only when this stage is reached do the outer coats of the investing organs become more or less dense by intra-cellular deposit. Detachment takes place at the hilum, and the embryo enclosed in its case becomes free as a "*seed.*" This is the resting stage in Phanerogamia. In Mosses, the germ being fertilized, its outer envelope or cellular investment becomes dense and firm, and no further development takes place within the general investing organ. The spore has attained the resting stage and is set free. The fertilized vesicle, now the spore, is no sooner placed in circumstances favourable for development, than dehiscence of the outer envelope takes place, the embryonal cell protrudes and elongates, transverse septa are formed, as in the case of the Phanerogamic germ-vesicle, a branched confervoid filament or septate cellular process is developed, which I submit is the homologue of the suspensor, and from a cell of this filament arises the phyllary axis, which bears in its turn the reproductive organ, and thus completes the cycle.

I do not pretend to offer this as a thoroughly proven exposition of the subject. I lay it rather before you somewhat in the shape of an hypothesis. Yet, if, after carefully weighing the subject, I had not felt it to be supported by observation, I should not have occupied the valuable time of this Meeting. No one can be more sensible of the incompleteness of this my first essay than myself. I am too truly a tyro in science to deem that I can teach. I can only venture to hope that I have touched chords of thought, that in abler and more skilful hands may evolve knowledge. Truth is so valuable, and opinion, unless accordant with truth, so worthless, that while I solicit your kind consideration even to the errors of my essay, I invite your free and candid criticism.

COMPARATIVE TABLE.

MUSCI.	PHANEROGAMIA.	FILICES.
ARCHEGONIUM OR SPORANGIUM.	OVARIUM.	SPORANGIUM OR THECA.
Nucleal Germ.	Placental Bud.	Axile Bud or Spore. RESTING STAGE.
Sporular Envelope.	Ovular Envelopes. = *Primine.* *Secundine.* *Embryo-sac.*	Pro-Embryo.
Embryonal Cell.	Germinal Vesicle.	Archegonial Cell.
		
Fertilized Embryonal Cell or Spore. RESTING STAGE.	Fertilized Germinal Vesicle.	Fertilized Archegonial Cell.
Confervoid pro-Embryo.	Confervoid Suspensor.	Septate Cellular Process.
Plumular Bud.	Radicle. Plumule. RESTING STAGE.	Radicle. Plumular Bud.
Phyllary Axis.	Phyllary Axis.	Phyllary Axis.

DESCRIPTIVE TABLE.

	MUSCI.	PHANEROGAMIA.	FILICES.
GENERAL INVESTING ORGAN.	Archegonium or Sporangium.	Ovarium.	Sporangium or Theca.
SPECIAL INVESTING ORGAN.	Sporular Membrane.	Ovular Envelopes. — Primine. Secundine. Embryo-sac.	Pro-Embryo.
GERMINAL BODY.	Embryonal Cell.	Germinal. Vesicle.	Archegonial Cell.